METHOD AND APPARATUS FOR DETERMINING THE INTERMEDIATE CIRCUIT CURRENT OF A CONVERTER

TECHNICAL FIELD

[0001] The present disclosure relates to a method and a device for determining the intermediate circuit current of a power converter.

BACKGROUND

[0002] Particularly in connection with the implementation of standards relating to the functional safety of electrically driven motor vehicles, knowledge of the state variables of the drive is necessary. In doing so, the use of costly sensors is problematic. For example, the monitoring of a three-phase motor is known from WO 2013 017 515 A1. The motor is powered by a power inverter. The power inverter is connected downstream of an intermediate circuit. Monitoring is carried out by determining a power inverter output power on the basis of the determined output voltages and currents of the power inverter, which in turn is compared to an intermediate circuit power, which is determined on the basis of the measured intermediate circuit current and voltage.

[0003] Instead of measuring the intermediate circuit current, it is generally known to determine the intermediate circuit current of a power inverter as a function of the measured phase currents and the so-called switching functions or switching states of the bridge branches/semiconductor switches. This means that, in principle, a costly current sensor in the intermediate circuit can be avoided. Whether this approach can be used to determine the intermediate circuit current of a power inverter with sufficient accuracy, in particular within the framework of functional safety requirements, is questionable.

SUMMARY

[0004] It is an object of the present disclosure to determine the intermediate circuit current of a power converter as accurately as possible in a simple and inexpensive manner.

[0005] The object is achieved by a method for determining an intermediate circuit current of a power converter with switches for converting a direct voltage into an alternating voltage that includes the following steps: Measuring output currents of individual phases of the power converter. Measuring output voltages of the individual phases of the power converter. Determining switching functions of the individual phases that are assigned to the switches of the power converter. Determining, based on the measured output voltages, potential changes of the output voltages of the individual phases from negative potential to positive potential and from positive to negative potential. Correcting the switching functions of the individual phases as a function of the determined potential changes. And determining the intermediate circuit current as a function of the measured output currents of the individual phases of the power converter and as a function of the corrected switching functions that are assigned to the switches of the power converter.

[0006] The switching functions may be corrected by forming correction variables on the basis of the potential changes, which variables represent switch-on and switch-off delays of the switches along with dead times between the switch-on and switch-off of the switches of a bridge branch of the power converter, and the correction variables may be added to the switching functions.

[0007] An alternative method for determining an intermediate circuit current of a power converter with switches for converting a direct voltage into an alternating voltage, includes the following steps: Measuring output currents of individual phases of the power converter. Measuring output voltages of individual phases of the power converter. Determining, based on the measured output voltages, potential changes of the output voltages of the individual phases from negative potential to positive potential and from positive to negative potential. Deriving switching functions of the individual phases that are assigned to the switches of the power converter as a function of the determined potential changes. And determining the intermediate circuit current as a function of the measured output currents of the individual phases of the power converter and as a function of the derived switching functions that are assigned to the switches of the power converter.

[0008] The switching functions may be derived as a function of the potential changes in that either constant values=0 or constant values=1 are assigned to the measured output voltages of the individual phases between successive potential changes, depending on whether the potential is negative or positive, such that switching functions, whose function values change over time between the value=0 and the value=1, are provided.

[0009] Deriving the switching functions may also be carried out as a function of the potential changes in that the output voltages of the individual phases are measured by delta-sigma analog-to-digital converters and digital bitstreams thus available for the individual phases represent the switching functions as a function of the potential changes. The measured output currents of the individual phases may be weighted on the basis of the digital bitstreams.

[0010] With each method the output voltages may be measured by delta-sigma analog-to-digital converters.

[0011] A device that may configured to carry out the methods. That device may in particular be part of an electric vehicle.

[0012] The following detailed description is merely exemplary in nature and is not intended to limit the invention or the application and uses of the invention. Furthermore, there is no intention to be bound by any theory presented in the preceding background or the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1** is a schematic of a power converter circuit.

[0014] FIG. **2** is a partial view illustrating a first phase of the circuit as in FIG. **1**.

[0015] FIG. **3** is a timing diagram illustrating the relationship between a switching state and a voltage.

DETAILED DESCRIPTION

[0016] FIG. **1** shows a mechatronic system having a power converter **1**. In this example, the mechatronic system comprises an electric machine **2**. The electric machine **2** is, for example, a permanently excited synchronous machine with three phases a, b and c. Of course, the power converter **1** can also comprise only one or even more than three phases. The mechatronic system according to FIG. **1** is preferably used to drive a vehicle. The electric machine **2** is controlled or